PLASTIC LINED CANAL

This invention relates to a plastic lined canal and more particularly to a canal having a plastic liner therein for the purpose of reducing leakage from the canal.

BACKGROUND OF THE INVENTION

Canals, ditches, or trenches, which are here used synonymously, are widely used to transport liquids by gravity flow. There are thousands of miles of irrigation canals of various sizes in agricultural areas of the world, used to transport water to fields. Many have earthen bottoms and sides and many are lined with concrete or similar materials. Some are dug into the earth and some are dug in berms or dikes elevated above the surrounding countryside. Universally, they leak, either because they are earthen or because of cracks or other imperfections in the lining.

A wide variety of techniques have been used to lessen or control leakage from irrigation ditches and canals with more or less success. Some techniques simply dump clay or swellable materials such as bentonite into the canal on the theory that the clay particles will migrate to the source of the leak and seal off the leakage. Other techniques involve applying plastic liners to the canals, none of which have heretofore been both successful and

cost effective. All techniques are costly to greater or lesser extent.

Disclosures relevant to the disclosure of this invention are found in U.S. Patents 4,741,645; 5,213,438; 5,568,995; 5,573,351; 5,613,804; 5,735,638 and 5,882,145.

SUMMARY OF THE INVENTION

In this invention, a plastic liner is mechanically fastened to the canal in such a way that the fastener does not pass through the membrane providing leak protection. This is accomplished by providing a tab or flap on the side of the membrane adjacent the canal and passing the fastener through the tab or flap. The membrane is typically wide enough to pass up and drape over the edge of the canal. The exposed edge is terminated in a suitable permanent manner.

The membrane is preferably of a plastic material reinforced by strong fibers, preferably in a mesh. The membrane is preferably sufficiently strong that, even after being cut with an instrument, the cut cannot be enlarged by pulling on the material adjacent the cut. Preferably, the tear strength of the material is above 100 pounds of force. A preferred material is commercially available and has a tear strength of 130 x 110 pounds of force.

Preferably, one or more tabs or flaps on the membrane extend along the length of the trench, one near the bottom of the trench and one or more on each side. The membrane is unrolled in any suitable manner to place the tab parallel to and in the canal. In the case of a concrete lined canal, a pilot hole is drilled in the concrete and a fluted concrete nail or concrete screw is placed through a washer or suitable load spreading device, through the tab and driven into the pilot hole. In the case of an earthen canal, anchors are driven into the earth along the length of the canal and members extending down the canal are connected to the anchors. A fastener is driven through the tab and into the members.

In this manner, a durable plastic liner is mechanically connected to the canal thereby substantially reducing leakage in a cost effective manner without passing a fastener through the leak reducing membrane.

It is an object of this invention to provide an improved plastic liner for a canal.

A further object of this invention is to provide a plastic liner mechanically connected to a canal in such a manner that the fasteners do not penetrate the leak protective membrane.

These and other objects and advantages of this invention will become more apparent as this description proceeds, reference being made to the accompanying drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional/isometric view of a canal provided with a liner of this invention;

Figure 2 is an enlarged view of the plastic liner, illustrating the leak protective membrane and the fastening tabs;

Figure 3 is a longitudinal cross-sectional view of the plastic liner and canal, as viewed from the center of the canal;

Figure 4 is an enlarged cross-sectional view of the plastic liner of Figure 2, taken substantially along line 4--4 thereof, as viewed in the direction indicated by the arrows;

Figure 5 is an enlarged cross-sectional view of an end of the plastic liner;

Figure 6 is an enlarged cross-sectional view of a bar used in terminating an end or edge of the plastic liner;

Figure 7 is an isometric view of a fastening system for securing a plastic liner to an earthen canal which has been broken away down the centerline of the canal to expose anchors in the earth;

Figure 8 is a longitudinal cross-sectional view of the earthen canal of Figure 7, as viewed from the center of the canal illustrating a framework to which a plastic liner is attached; and

Figure 9 is an enlarged broken isometric cross-sectional view of the earthen canal of Figures 7-8.

DETAILED DESCRIPTION

Referring to Figures 1-6, a canal 10 has been excavated from the earth 12 below ground level 14 to provide a gravity flow, open top channel having a bottom 16, side walls 18 and a pair of generally identical parallel edge or top structures 20, 22. A conventional concrete liner 24 has been installed originally providing a more-or-less impermeable barrier to water or liquid loss. Those skilled in the art will recognize the canal 10 as representative of irrigation canals common in many agricultural areas of the world.

Because many of such canals 10 have been in use for long periods, the concrete lining 24 has been cracked, usually by soil movement due to expansion and contraction of the underlying earth 12 due to wetting and drying of the soil. In some situations, very large percentages of water delivered to the canal system is lost before it reaches its destination. Because only a small percentage of the lost water is due to evaporation, the vast bulk of shrinkage is from seepage through the concrete liner 24. This is not surprising because close inspection of concrete lined canals reveals that large cracks are common in some areas. If large water losses are common in concrete lined canals, it is easy to understand that even larger losses are sustained in earthen or unlined canals. There are a number of techniques to repair cracked

concrete lined canals, none of which have heretofore had the desirable combination of low cost and being effective.

In this invention, an impermeable plastic liner 26 is mechanically attached to the canal 10 thereby preventing the liner 26 from moving relative to the canal 10 and eliminating or drastically reducing leaking of water from the canal. Because the fasteners do not extend through the water protective membrane, the canal is made impermeable for the length of the plastic liner 26.

To this end, the liner 26 includes a series of attachment tabs or flaps 28, 30 between the liner 26 and the concrete lining 24. As shown in Figure 2, the tabs 28, 30 are of two different types. The plastic liner 26 is typically made of several long sections bonded together in seams 32. Where it is desirable to provide an attachment tab adjacent a seam 32, a section 34 of the liner 26 is attached to a section 36 away from the end of the section 36 to leave the tab 28. Where it is desirable to provide an attachment tab intermediate the edges of a liner section 38, a piece of material 40 is attached to the section 38 thereby providing the tab 30.

As shown best in Figures 2-4, a pilot hole 42 is drilled at least part way through the concrete liner 24, the tab 28 is pulled upwardly to overlie the pilot hole 42, a washer 44 is placed over the pilot hole 42 and a fastener 46 is driven into the pilot hole

42. The fastener 46 may be of any suitable type, such as a fluted concrete nail, a concrete screw, a concrete anchor or the like. The fasteners 46 are driven through the tabs 28, 30 along the length of the tabs at suitable intervals, e.g. 6-24" apart. It will be seen that the fasteners 46 provide a head between the liner 26 and the tabs 28, 30 and do not penetrate the impermeable liner 26.

Preferably, the plastic liner 26 is attached in a first path along the bottom 16 of the canal 10, e.g. along a centerline of the concrete lining 24 and on one or more paths on the sides 18. Figure 1 shows a center attachment path and two attachment paths on each side of the concrete liner 24.

An important but subtle feature of this invention is shown in Figure 2 where the tabs 28, 30 away from the centerline have their free ends 48, 50 above the fixed ends 52, 54. There are two reasons for this arrangement, the most important of which has to do with the manner in which the plastic liner 26 is rolled out in the bottom of the canal 26 and unfolded during installation as will be more fully apparent hereinafter. In addition, the tabs on the sides 18 of the canal 10 are in tension and the tabs manifestly hang better with the free ends 48, 50 above the fixed ends 52, 54.

The plastic liner 26 is preferably made of an unusual material. The preferred material is a fiber reinforced polyvinyl

chloride copolymer commercially available from Duro-Last, Inc. of Saginaw, Michigan. The fiber reinforcement is an 18 x 14 pattern, weft inserted polyester scrim. The polyvinyl chloride copolymer is weldable by the application and heat and pressure in a conventional manner, using a hot air gun to provide the heat and a roller to provide the pressure. It will accordingly be seen that the seam 32 and the tab 30 are provided by welding sections of like material together. The preferred material has a minimum tear strength of 100 pounds force, meaning that at least 100 pounds of force are necessary to tear the material, and preferably has a tear strength of 130 x 110 pounds force, meaning that the material is stronger in one direction than in a direction perpendicular thereto. This is sufficient that cuts made in the material with an instrument are not enlarged by manually pulling on the material adjacent to the cut.

The liner 26 is installed in any suitable manner. The liner 26 is commercially available from manufacturers such as Duro-Last, Inc., of Saginaw, Michigan. Preferably, in the process of manufacture, the liner 26 is made of any desirable width, and is wide enough to drape over the upper edges 20, 22 of the concrete liner 24. In the process of manufacture, the liner 26 is folded to be of a width substantially less than the width of the canal 10 and having a central fastening tab 30 laid out along one edge of the

rolled material. The folded liner 26 is rolled up at the manufacturer's plant and transported to the job site. The length of the liner 26 in any one roll is selected to be suitable to the effort required to handle the roll and is of a convenient length, e.g. 50'. A modest crew can easily handle fifty foot lengths.

At the job site, the rolled liner 26 is placed in the canal 10 and unrolled so the central fastening tab 30 extends along or generally parallel to a centerline of the canal. Fasteners 46 are driven through the tab 30 thereby securing a central portion of the liner 26 in the canal. The uppermost folded section of the liner 26 is then unfolded and moved toward the side of the canal 10. Fasteners 46 are driven through the next adjacent fastening tab 28 along the length of the liner 26. This process of unfolding a section of the unrolled liner and securing it to the canal is repeated until the outside edges of the liner 26 are passed over the top edges 20, 22 of the canal and placed in narrow trenches 56 parallel to and adjacent the top edges 20, 22. The trenches 56 are filled with concrete thereby making a suitable permanent termination of the liner edges.

When the next adjacent liner section is to be attached to an existing liner, the liner sections are cleaned, overlapped and welded together in a conventional manner. Because the material of the liner 26 is preferably thermoplastic, this is accomplished by

use of a conventional hot air gun providing heat and a roller providing pressure, similar to the seams made by the manufacturer. The process of laying liner sections end to end is repeated until the desired length of the canal 10 is lined with the liner 26.

When it is desired to terminate the liner 26 in the canal 10 or make an accommodation for a branch of the canal leading off at an angle to the main canal, a termination 58 is made as shown in Figures 5-6. A caulk strip 60 is placed under the liner 26 a short distance from the end. A termination bar 62 is laid on top of the liner 26 immediately above the caulk strip 60. The caulk strip 60 and termination bar 62 are sufficiently long to extend above the water line on each side of the canal 10 up to at least the upper edges 20, 22. Suitable fasteners, such as fluted nails or concrete screws, are driven through openings 64 in the termination bar 62 compressing the caulk strip 60 and securing the end of the liner 26 to the canal 10. The free end 66 of the liner 26 is reversed over the top of the termination bar 62 and sealed to the liner 26 in any suitable manner, as by the application of heat and pressure.

It will accordingly be seen that the liner 26 of the invention provides an effective impermeable barrier against leakage of water or other liquid from the concrete lined canal 10.

Referring to Figures 7-9, there is illustrated an earthen canal 70 excavated from the earth 72 below ground level 74 to

provide a gravity flow, open top channel having a bottom 76 and side walls 78. To secure a plastic liner in the canal 70, a suitable framework 80 is provided to which the liner is secured. To this end, a series of anchors 82 are driven into the earth in paths extending parallel to the length of the canal 70. As will be more fully apparent hereinafter, the paths of the anchors 82 correspond to the position of the fastening tabs or flaps of the plastic liner.

The anchors 82 may be of any suitable type and are illustrated as auger or screw type anchors similar to those used in anchoring mobile homes to the earth. Thus, the anchors 82 have a shaft 86 providing a helical flange 88 adjacent the bottom. The anchors are driven into the earth with a suitable powered device so the upper end of the shaft 84 is at, or slightly below, ground level.

A series of longitudinally extending members 90 are attached to the anchors 82 in any suitable manner, as by the provision of a fastener 92 and washer 94. The members 90 are preferably corrosion resistant and have sufficient mechanical strength to receive mechanical fasteners and stabilize the plastic liner. To this end, the members 90 are preferably aluminum alloys, plastic or the like and may comprise structural shapes such as angles, boxes or I-beams.

After the framework 80 is installed, a rolled up plastic liner 96 is laid in the canal 70 and unrolled, in the same manner that the plastic liner 26 is unrolled in the concrete lined canal 10 so a longitudinally extending tab or flap 98 extends parallel to the length of the canal 70 adjacent to the member 90 which lies along the canal centerline. The tab 98 is connected to the member 90 by drilling a series of pilot holes in the member 90, placing the tab 98 over the pilot hole and driving a nail or screw 100 through a washer 102 into the pilot hole. After the center of the plastic liner is secured to the central member 90, the plastic liner 96 is unfolded and then secured to the next adjacent member 90. In a sense, the framework 80 and the members 90 act as a mechanical support for the plastic liner 96 in much the same manner that the concrete liner 24 acts as a support for the liner 26. The sides of the plastic liner 96 extends over the top of the canal 70 and into a pair of trenches 104 in the same manner as the liner 26.

Although this invention has been disclosed and described in its preferred forms with a certain degree of particularity, it is understood that the present disclosure of the preferred forms is only by way of example and that numerous changes in the details of operation and in the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.